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# Management of Soybean Rust with Foliar Fungicides

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## Introduction

Soybean rust has the potential to decrease profits directly by reducing yield and/or increasing the cost of production. There are effective fungicides available for management of soybean rust (Miles et al. 2007). However, correct application timing of foliar fungicides and adequate coverage is important for management of soybean rust and maximizing soybean yield.

In 2007, several fungicides that received Section 18 labels for soybean rust in 2004 were granted Section 3 labels for use on soybean. Section 18 labels for Folicur and Headline SBR will need to be renewed for these fungicides to be available in Iowa in 2008. See Table 1 for a update on the status of available fungicides.

**Table 1.** Status of fungicides for soybean rust in Iowa.

| Active ingredient | Product (trade name) | Section 18 status in Iowa | Section 3 registration status |
|---|---|---|---|
| azoxystrobin | Quadris | – | Registered |
| azoxystrobin + propiconazole | Quilt | – | Registered |
| chlorothalonil | Bravo, Echo, Equus | – | Registered |
| myclobutanil | Laredo EC, Laredo EW | – | Registered |
| propiconazole | Tilt, PropiMax, Bumper | – | Registered |
| propiconazole + trifloxystrobin | Stratego | – | Registered |
| pyraclostrobin | Headline | – | Registered |
| tetraconazole | Domark | – | Registered |
| azoxystrobin + cyproconazole | Quadris Xtra | expires 3/31/09 | Decision expected in early 2008 |
| cyproconazole | Alto | expires 3/31/09 | Decision expected in early 2008 |
| flusilazole | Punch | expires 6/15/10 | Decision expected in 2009 |
| flutriafol | Topguard | expires 2/12/10 | Decision expected in early 2009 |
| metconazole | Caramba | expires 4/19/09 | Decision expected in late 2008 |
| tebuconazole | Folicur, Orius, Uppercut | expires 11/10/07 | Decision expected in late 2008 |
| tebuconazole + pyraclostrobin | Headline SBR | expires 11/10/07 | Registrant has not made a decision on the fate of this product. |
| famoxadone + flusilazole | Charisma | pending | Decision expected in 2008 |
| prothioconazole | Not available | pending | Decision expected in late 2007 |
| tebuconazole + trifloxystrobin | Absolute | none | Decision expected in late 2007 |

## Fungicide timing

Well-timed applications of fungicides may improve fungicide efficacy and help growers reduce the total number of applications needed for soybean rust management and subsequently have provided a direct economic benefit. Fungicide timing was evaluated in three countries (Paraguay, Zimbabwe and U.S.) in 2005 and 2006. Treatments at each location included Folicur, Headline, or Quilt applied at either growth stage (GS) R1, R3, or R5. Multiple fungicide applications were evaluated as well, but are not presented. An unsprayed control was included for comparisons.

In all locations, rust was assessed visually in each plot using a scale from 0 to 5; in which a rating of 0 = no disease, 1 = low disease severity (1-10% of leaf area affected), 2 = medium-low disease severity (10-25%), 3 = medium disease severity (25-50%), 4 = medium-high disease severity (50-75%), and 5 = high disease severity (75-100%). The midpoint value of each rating range was used to convert the rating to an index percentage. Most locations were assessed at least three times between flowering and seed set.

## Results

Based on when soybean rust was first observed, the seven locations were divided into three categories; a) rust infection occurring early, b) rust infection first occurring near GS R4 and c) rust infection occurring very late (Table 2). When rust first appeared in the field at-or-near GS R1 (Capitan Meza and Pirapo, Paraguay), fungicide timing was most critical. When fungicides were applied after infection, especially 30—36 days after first infection, fungicides were not effective. When rust first appeared in the field near GS R4 (Florida and Georgia), early fungicide applications resulted in less soybean rust control, but yield loss did not reflect this decrease. When rust first appeared in the field near GS R5 (both locations in Bella Vista Paraguay and Zimbabwe), fungicides did not have an effect on either soybean rust or yield.

In general, fungicide applications closest to when soybean rust was first observed had the lowest amount of rust and the highest yields, with few exceptions. Some treatments did not reduce rust severity or increase yields compared to the unsprayed plots. This was due to the timing of the fungicide application in relation to rust development especially when rust was first observed either early (soon after GS R1) with late fungicide application (30-36 days after rust was observed) or soybean rust developed late in the season and did not cause significant yield loss. Fungicide timing was more critical when soybean rust arrived earlier in the season, and there was a larger margin of error for fungicides applied prior to soybean rust development than fungicides applied after soybean rust development.

**Table 2.** Effectiveness of fungicides at different timings in seven locations in 2005 or 2006.

| | DFO [a] | | | Percent control [b] | | | Percent yield increase [c] | | |
|---|---|---|---|---|---|---|---|---|---|
| **Location** | **R1** | **R3** | **R5** | **R1** | **R3** | **R5** | **R1** | **R3** | **R5** |
| Capitan Meza, Paraguay (2006) | -13 | 10 | 30 | 96 a | 90 a | 51 b | 30 a | 23 a | 7 b |
| Pirapo, Paraguay (2006) | -4 | 16 | 36 | 94 a | 55 b | 37 c | 141 a | 89 b | 8 c |
| Quincy, Florida (2006) | -32 | -11 | 9 | 36 b | 60 a | 67 a | 12 b | 28 a | 34 a |
| Attapulgus, Georgia (2006) | -35 | -14 | 9 | 64 b | 79 a | 77 a | 22 a | 29 a | 18 a |
| Bella Vista, Paraguay (2005) | -47 | -21 | 0 | 55 a | 58 a | 57 a | 35 a | 35 a | 35 a |
| Bella Vista, Paraguay (2006) | -33 | -14 | 0 | 77 a | 77 a | 87 a | 8 a | 11 a | 11 a |
| Enterprise, Zimbabwe (2006) | -30 | -15 | 0 | 48 b | 49 b | 70 a | 23 a | 23 a | 20 a |

[a] DFO = days from first observation of soybean rust to application of fungicide (negative numbers means that the fungicide was applied before first observation).

[b] Data averaged from three fungicide treatments (Folicur, Headline and Quilt). Calculated by [1-(amount of rust in treated plots/ amount of rust in untreated plot)]*100. The higher the number, the more effective the fungicide treatment.

[c] Data averaged from three fungicide treatments (Folicur, Headline and Quilt). Calculated by [1-(yield in untreated plots/ yield in treated plot)]*100. The higher the number, the greater the yield response.

* For both the percent control and percent yield increase columns, numbers followed by the same letter within a row are not significantly different.

## Fungicide coverage

In the event that an epidemic were to occur, effective use of fungicides is critical. Part of this effectiveness has to do with fungicide deposition or leaf coverage, which can be altered by various factors such as spray pressure, type of nozzles, and the volume of water used to apply the fungicide product (Ozkan et al. 2005).

Nozzle tips, pressure and application volumes were evaluated to determine their effect on fungicide coverage on leaves in the upper and lower canopy, and how the resultant coverage impacted soybean rust severity and yield. Coverage was determined using Kromekote paper cards that were placed at two heights (1/3 and 2/3 of canopy height) in the soybean canopy, and Vision Pink Dye was tank-mixed to mark the droplet pattern on the cards. Folicur was applied at three pressures (30, 50, or 70 pounds per square inch (psi)), with two nozzle types (Turbo Teejet or Ultra Lo-Drift), and at two different volumes of water (10 or 20 gallons per acre (gpa)). An unsprayed control was included for comparison. The experiment was completed in Florida and Georgia in 2006.

## Results

Soybean rust was first observed in both locations near GS R4. The 20 gpa treatment consistently had significantly more leaf coverage in both the upper and lower canopy compared to 10 gpa treatment (Figure 1). However, this does not mean that there is more fungicide applied per leaf, but that twice as much of the leaf is covered with the same amount of fungicide. While not always statistically different, coverage for treatments at 70 psi was better than at 50 and 30 psi in the upper canopy, but little differences in coverage were observed in the lower canopy at all pressures (Figure 2).

There were no differences in coverage between the two nozzles when applying fungicides (Figure 3). However, the Ultra Lo-Drift nozzle tips had larger droplet sizes than Turbo Teejet nozzle tips. Also, treatments at 30 psi had larger droplet sizes than treatments at 70 psi (data not shown).

When combining all three factors, fungicides applied using the Turbo Teejet nozzle applied and 20 gpa at 70 psi resulted in the best coverage. But did this improved coverage translate in better management of soybean rust and improved yield? All treatments had lower rust severity and higher yield than the untreated control, but there were no differences among treatments (Figures 4 and 5). This means that as long as Folicur was applied at the right time and adequate coverage was attained, adjustments to improve the coverage did not result in increased fungicide efficacy or increased soybean yield. Soybean rust caused a 13% yield loss when the fungicide treatments were compared with the untreated control.

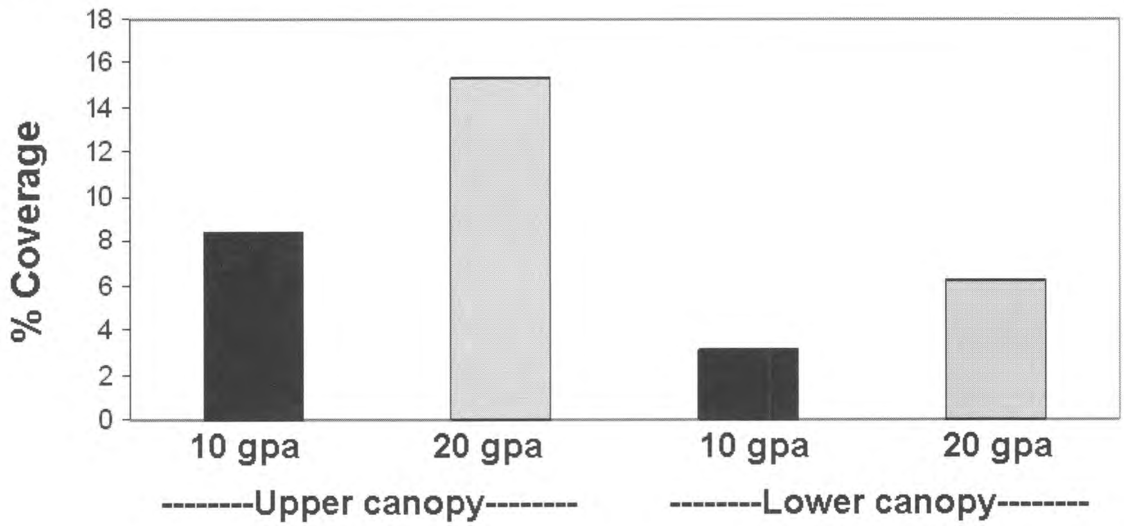


**Figure 1.** Percent coverage in the upper and lower canopy applying fungicides at different application volumes (10 and 20 gpa).

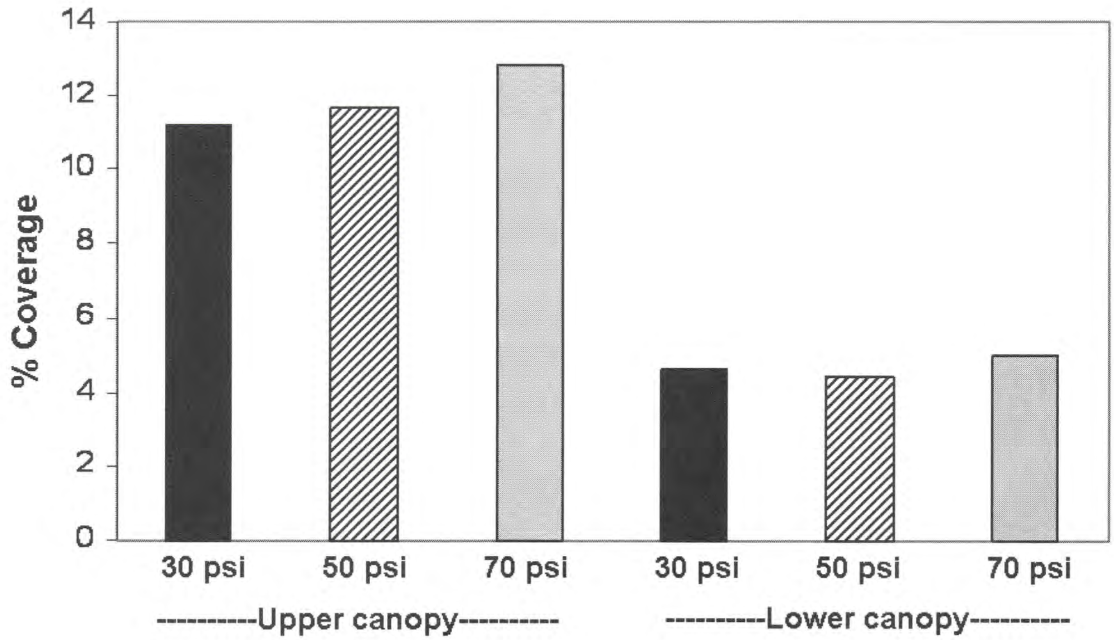


**Figure 2.** Percentage coverage in the upper and lower canopies applying fungicide at 30, 50 and 70 psi.

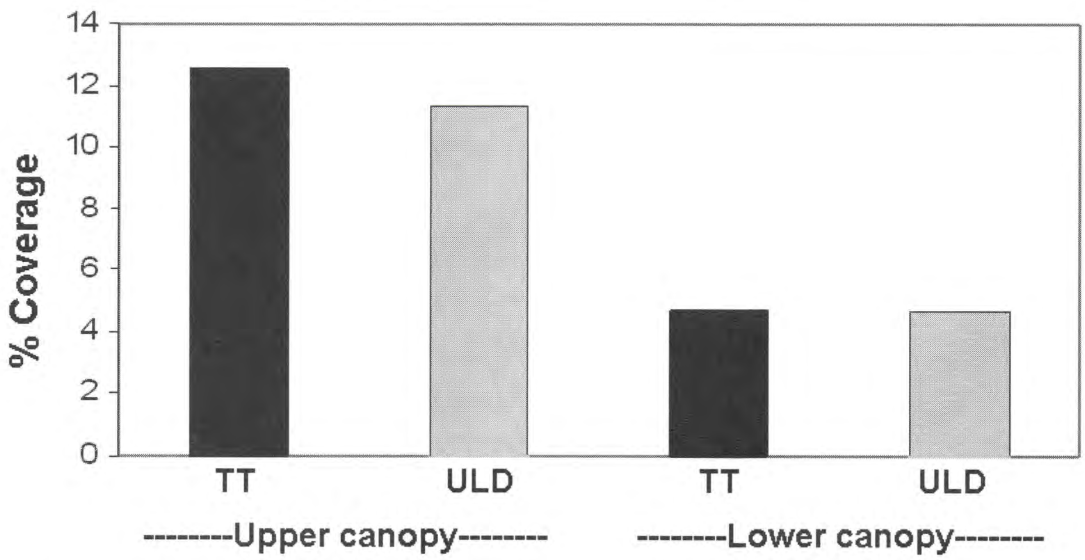


**Figure 3.** Percentage coverage in the upper and lower canopies applying fungicide with different nozzles. TT= Turbo TeeJet nozzle tips manufactured by Spraying Systems Co.; and ULD= Ultra Lo-Drift nozzle tips manufactured by Hypro.

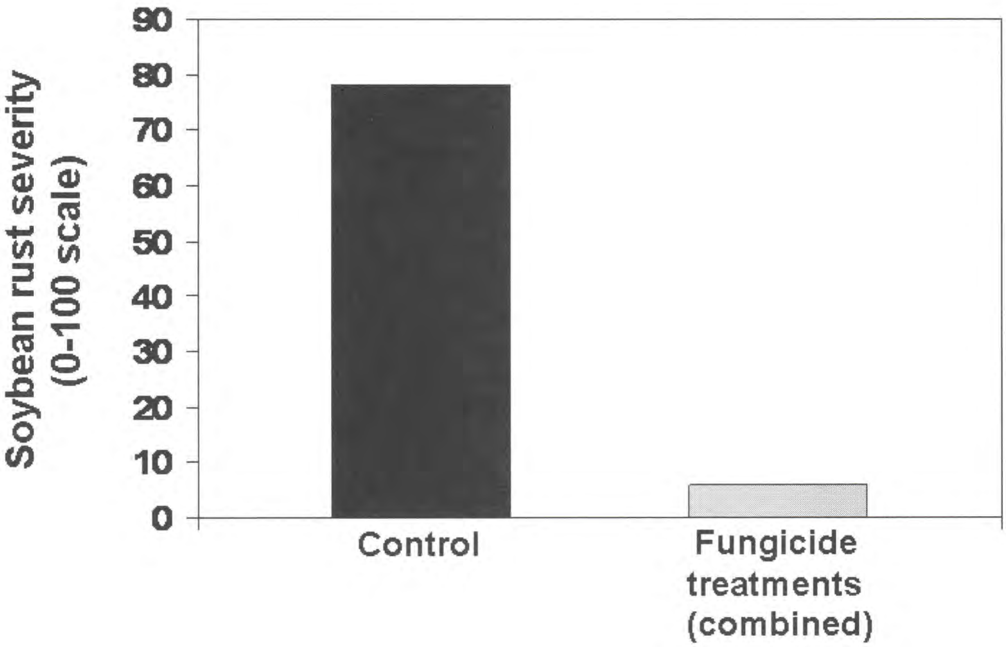


**Figure 4.** The effect of pressure, application volume, and nozzle tip type on soybean rust severity. All treatments were combined because there were no significant differences between treatments.

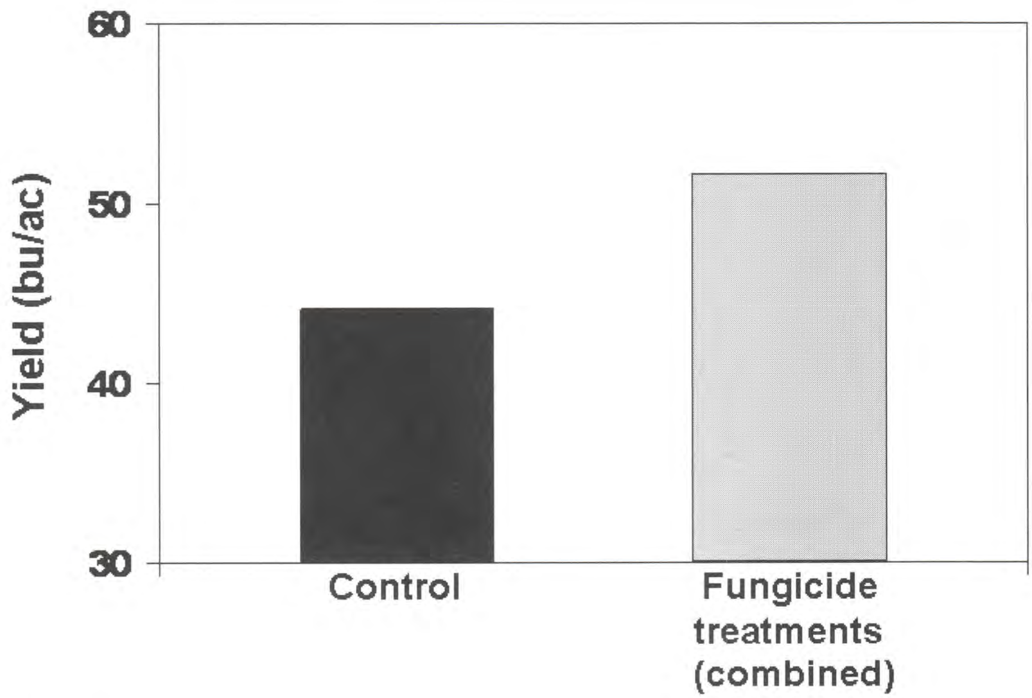


**Figure 5.** The effect of pressure, application volume, and nozzle-tip type on soybean yield. All treatments were combined because there were no significant differences between treatments. Yields ranged from 50.1 to 53.8 bu/ac for treatments with fungicides and the control was 44.1 bu/ac.

## Summary

There are about 70 million acres of soybeans grown annually in the U.S. including about 8 to 10 million acres in Iowa. If soybean rust were to become epidemic, the acreage needing treatment with fungicides will create a logistical challenge. Proper application timing and complete canopy coverage both are important for maximizing the effectiveness of fungicides for management of soybean rust. The results from these studies indicate that management of soybean rust with foliar fungicides may not be as daunting as originally expected.

Application timing is more critical than coverage. Fungicide applied closest to the first observed soybean rust infection was the most effective, especially when soybean rust becomes established in a field during the early soybean reproductive growth stages. The later soybean rust was established, the less critical fungicide timing became because the potential impact on yield was less.

While fungicide timing is critical for management of soybean rust and preserving yield, coverage does not appear to be as critical, at least for Folicur. These results do NOT suggest that corners can be cut when applying fungicides to manage soybean rust. These data do show that systemic fungicides (triazoles) may only need "normal" coverage. Maximizing coverage with specialized spraying systems or even slightly adjusting existing systems to improve canopy coverage may not be as necessary for management of soybean rust when using systemic fungicides.

Fungicide trials in states with a history of soybean rust already show that there are differences in efficacy of fungicides for management of rust. These more effective fungicides may have a wider window of timing and a greater ability to compensate for less-than-ideal coverage than the marginal fungicides. Future research is needed to assess what these differences are between fungicide products.

## References

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